CLAIMS

1. A semiconductor device characterized in that an electromagnetic wave transmission signal is transmitted from a transmitting antenna placed on a semiconductor substrate to a receiving antenna placed on the semiconductor substrate or receiving antennas placed on a plurality of semiconductor substrates such that wireless interconnection is accomplished, the semiconductor substrates have broadband transmitting/receiving antennas respectively, a signal is transmitted from one or more of the semiconductor substrates and received with the receiving antenna of the semiconductor substrate or the receiving antennas of the semiconductor substrates, and the signal transmitted and received has an ultra-wideband communication function.

2. A semiconductor device characterized in that multilayer wires are arranged in a first interlayer insulating layer placed on a semiconductor substrate, the multilayer wiring metal layer has a transmitting antenna, the transmitting antenna is connected to internal metal wires with via-holes filled with metal, the wiring metal layer having the transmitting antenna is placed in a second interlayer insulating layer, top and bottom of the wiring metal layer being covered thereby, the second interlayer insulating layer has a dielectric constant different from

that of the first interlayer insulating layer adjacent thereto so as to satisfy the condition that an electromagnetic wave is totally reflected from the interface between the first and second interlayer insulating layers, and reflectors are arranged on a plane on which the antenna is placed in the direction opposite to a radiation direction.

3. A semiconductor device characterized in that multilayer wires are arranged in a first interlayer insulating layer placed on a semiconductor substrate, the multilayer wiring metal layer has a transmitting antenna, the transmitting antenna is connected to internal metal wires with via-holes filled with metal, the wiring metal layer having the transmitting antenna is placed in a second interlayer insulating layer, top and bottom of the wiring metal layer being covered thereby, the second interlayer insulating layer has a dielectric constant different from that of the first interlayer insulating layer adjacent thereto, reflectors are arranged on a plane on which the antenna is placed in the direction opposite to a radiation direction, and the following equations determine the relationship between the distance from the antenna to the internal metal wires and the thickness of the second interlayer insulating layer when an electromagnetic wave is not totally reflected from the interface between the first and second interlayer insulating layers:

total reflection angle = $\sin^{-1}\sqrt{}$ (dielectric constant of first interlayer insulating layer / dielectric constant of second interlayer insulating layer) (1)

total reflection angle = $\tan^{-1}\sqrt{}$ (distance from antenna to wire / thickness of second interlayer insulating layer) (2).

4. A semiconductor device characterized in that multilayer wires are arranged in a plurality of interlayer insulating layers arranged on a semiconductor substrate, the multilayer wiring metal layer has a transmitting antenna, the transmitting antenna is connected to internal metal wires with via-holes filled with metal, the wiring metal layer having the transmitting antenna is placed in a first interlayer insulating layer, top and bottom of the wiring metal layer being covered thereby, and the first interlayer insulating layer has a plurality of micro-pores that extend therethrough in the thickness direction thereof to form a photonic band gap at the frequency of an electromagnetic wave transmitted from the antenna.

5. A semiconductor device characterized in that multilayer wires are arranged in a plurality of interlayer insulating layers arranged on a semiconductor substrate, the multilayer wiring metal layer has a transmitting antenna, the transmitting antenna is connected to internal metal wires with via-holes filled with metal, the wiring metal layer having the transmitting antenna is placed in a first

interlayer insulating layer, top and bottom of the wiring metal layer being covered thereby, the first interlayer insulating layer has a plurality of micro-pores arranged in the thickness direction thereof, and the micro-pores are filled with second interlayer insulating layers having different dielectric constants so as to form a photonic band gap at the frequency of an electromagnetic wave transmitted from the antenna.

6. A semiconductor device characterized in that an electromagnetic wave transmission signal is transmitted from a transmitting antenna placed on a semiconductor substrate to a receiving antenna placed on the semiconductor substrate or receiving antennas placed on a plurality of semiconductor substrates such that wireless interconnection is accomplished, a multilayer wiring metal layer placed on the semiconductor substrate has a transmitting/receiving antenna, and the antennas are spaced from a ground metal substrate and internal metal wires such that the distance therebetween is greater than the far field distance determined depending on the wavelength of an electromagnetic wave propagated in a semiconductor:

distance = wavelength of wave propagated in Si substrate / 2π.

7. A semiconductor device characterized in that an electromagnetic wave transmission signal is transmitted from

a transmitting antenna placed on a semiconductor substrate to a receiving antenna placed on the semiconductor substrate or receiving antennas placed on a plurality of semiconductor substrates such that wireless interconnection is accomplished, and a low-dielectric constant insulating layer is placed between the semiconductor substrate and a ground metal substrate such that the distance between the antennas and the ground metal substrate and the distance between the antennas and internal metal wires are greater than the far field distance determined depending on the wavelength of an electromagnetic wave propagated in a semiconductor:

distance = wavelength of wave propagated in Si substrate / 2π.

8. A semiconductor device characterized in that an electromagnetic wave transmission signal is transmitted from a transmitting antenna placed on a semiconductor substrate to a receiving antenna placed on the semiconductor substrate or receiving antennas placed on a plurality of semiconductor substrates such that wireless interconnection is accomplished; a plurality of metal wiring layers are arranged perpendicularly to the radiation direction of the transmitting antenna, connected to each other with via-holes, and divided so as to have a length less than one eighth of the wavelength of an electromagnetic wave propagated in a semiconductor; and a power supply, a ground wire, and a

common wire are arranged in parallel to the radiation direction of the transmitting antenna.

9. A semiconductor device characterized in that an electromagnetic wave transmission signal is transmitted from a transmitting antenna placed on a semiconductor substrate to a receiving antenna placed on the semiconductor substrate or receiving antennas placed on a plurality of semiconductor substrates such that wireless interconnection is accomplished, the semiconductor substrates are arranged so as to achieve multilayer integration, ground metal layers are each placed on the rear face of the semiconductor substrate and the rear face of the outermost semiconductor substrate located most far from the semiconductor substrate such that the ground metal layers cover the rear faces of the semiconductors and face outward, the other semiconductor substrates have no ground metal layers, and ground contact is achieved with a substrate surface.

10. A semiconductor device characterized in that an electromagnetic wave transmission signal is transmitted from a transmitting antenna placed on a semiconductor substrate to a receiving antenna placed on the semiconductor substrate or receiving antennas placed on a plurality of semiconductor substrates such that wireless interconnection is accomplished, ground metal layers having a strip shape are arranged on the rear face of the semiconductor substrate and

have a width less than one fourth of the wavelength of an electromagnetic wave propagated in a semiconductor, and the interval between the ground metal layers is greater than one fourth of the wavelength of such an electromagnetic wave propagated in a semiconductor.

11. A semiconductor device characterized in that an electromagnetic wave transmission signal is transmitted from a transmitting antenna placed on a semiconductor substrate to a receiving antenna placed on the semiconductor substrate or receiving antennas placed on a plurality of semiconductor substrates such that wireless interconnection is accomplished, a lens-shaped insulating layer which is made of a material for forming a first or second interlayer insulating layer and which has a parabolic surface is placed above the transmitting antenna, the first and second interlayer insulating layers have different dielectric constants, and a metal layer is placed on the lens-shaped insulating layer.

12. A semiconductor device characterized in that an electromagnetic wave transmission signal is transmitted from a transmitting antenna placed on a semiconductor substrate to a receiving antenna placed on the semiconductor substrate or receiving antennas placed on a plurality of semiconductor substrates such that wireless interconnection is accomplished, and timing is adjusted using delay times of a

clock-receiving circuit when a synchronous clock signal radiated from the transmitting antenna is received with the receiving antennas, the delay times being obtained by dividing the distances from the transmitting antenna to each of the receiving antennas by the electromagnetic wave transmission speed.

13. A semiconductor device characterized in that an electromagnetic wave transmission signal is transmitted from a transmitting antenna placed on a semiconductor substrate to a receiving antenna placed on the semiconductor substrate or receiving antennas placed on a plurality of semiconductor substrates such that wireless interconnection is accomplished, the semiconductor substrates are arranged at equal intervals so as to achieve multilayer integration, a transmitting/receiving antenna placed on the semiconductor substrate is placed on the same side as that on which the transmitting antenna is placed and serves as a relay for a synchronous clock signal radiated from the transmitting antenna, and the maximum time obtained by dividing the distances between the transmitting and receiving antennas by the electromagnetic wave transmission speed is less than one fourth of the clock period.

14. A semiconductor device characterized in that an electromagnetic wave transmission signal is transmitted from a transmitting antenna placed on a semiconductor substrate

to receiving antennas placed on a plurality of semiconductor substrates such that wireless interconnection is accomplished, the semiconductor substrates are arranged at equal intervals so as to achieve multilayer integration, and the transmitting and receiving antennas placed on the semiconductor substrates serve as broadband antennas that have a band with a transmission gain of -10 dB being greater than or equal to 25% of the center frequency.